CATALYTIC PERFORMANCE AND COKING RESISTANCE OF MODIFIED Ni/GDC ELECTRO-CATALYSTS FOR BIOGAS FUELED SOFCs

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ABSTRACT

Recycling biogas to produce syngas (H_2 + CO) through Dry Reforming of Methane (DRM) has currently attract resurgent interest. Biogas consists mainly of CH_4 (50-70%) and CO_2 (25-50%) and is widely produced by anaerobic fermentation of biomass [1]. DRM provides a feasible solution to eliminate greenhouse gases via production of useful chemicals and hydrocarbons.

Considering the DRM energy applications the produced syngas can be used as a fuel in high temperature solid oxide fuel cells (SOFCs) for electricity production or biogas can be directly fueled in the cell without the need of an external reformer (Internal Dry Reforming of Methane, IDRM), which simplifies the SOFC system and reduces the cost [2,3]. Specifically, during IDRM at temperatures higher than 800 ^oC, the catalytic Reverse Water Gas Shift (RWGS) reaction may run in parallel with electrocatalytic reactions, resulting in the consumption of valuable H_2. In addition, carbon deposition on the electrocatalyst surface due to CH_4 decomposition, which is favored at elevated temperatures (≥ 700 ^oC), may also occur resulting in progressive electrocatalyst deactivation [4].

Ni-based ceramic-metal composites with Yttria Stabilized Zirconia (YSZ) and Gadolinia Doped Ceria (GDC) are widely used as electrocatalysts in SOFCs because of their activity and inexpensiveness. However, nickel catalyses the formation of carbon deposits from hydrocarbons and exhibits a tendency to agglomerate after prolonged operation [3,4]. The carbon tolerance and anti-sintering tendency of nickel and specifically of Ni/GDC can be enhanced, by dispersing trace amounts of transition noble (Rh, Pt, Pd, Ru, Au) or non-noble (Co, Cu, Mo, Fe) metal elements [3,5].

In this study the performance of Ni/GDC, 1 wt.% Au-Ni/GDC, 3 wt.% Au-Ni/GDC, 0.5 wt.% Fe-Ni/GDC, 2 wt.% Fe-Ni/GDC, 3 wt.% Au-3 wt.% Mo-Ni/GDC and 3 wt.% Au-0.5 wt.% Fe-Ni/GDC electrodes have been studied, at open-cirquit potential conditions, under biogas fuel operation in single SOFCs. The electrodes have been tested in the form of half-electrolyte supported cells, at 750-900 ^oC, under a fuel with a ratio of CH_4 to CO_2 equal to 1 and for total gas flows varying from 150 to 300 cc/min. The catalytic kinetic measurements were carried out under differential conditions, at various CH_4 and CO_2 partial pressures. In addition, the catalytic CH_4 dissociation reaction at 800 ^oC and other physicochemical properties of the powders were examined via TGA, XRD and H_2-TPR.

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